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THE MISSISSIPPI GULF THREE MILLION YEARS AGO

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THE traveler from Chicago to New Orleans, if on the fastest train, leaves Cairo, Illinois, at 3.40 A.M. and covers the 566 miles to the Crescent City in 17¼ hours. Little does he realize that all this while the train is speeding along an old bed of the sea.

At the dawn of that stage of the earth's history, which geologists call the Cenozoic or era of modern life, the waves of the Gulf of Mexico rolled northward as far as southern Illinois. This area of submergence, which was covered many times by ocean waters during geologic time, has been called the Mississippi embayment or Gulf. It was no narrow arm of the sea like the Gulf of California, but a broad expanse of water with its shores receding rapidly from one another as they passed to the southward. At Jackson, Mississippi, the traveler is over one hundred miles from the old eastern shore and the western shore is more than 350 miles to the westward.

The old eastern shore bends to the eastward in Kemper County, Mississippi, and all the region to the southward was under water. The sites of Memphis, Meridian, Vicksburg and Shreveport were all submerged, although the water was never very deep, as is shown by the forms of marine life preserved as fossils in the sediments. Probably a ship, if there had been ships in those ancient days, could have anchored anywhere in the Gulf, since it was nowhere over 50 fathoms deep and throughout most of its area it was much shallower.

Perhaps a long familiarity has bred an indifference to the wonders of the past hidden in the sands and clays of the eroded hill country, but more likely the story that they have to tell is entirely unsuspected. Geologists have studied these sands and clays, collecting the fossil shells and petrified woods from the sands and the impressions of leaves and other parts of plants entombed in the clays. They have named and described many of these ancient forms of life, both the dwellers in the sea and on the land, and have mapped the landward margin of the deposits that give us a picture of the position of the old shore line.

The Cenozoic era is divided into distinct periods the oldest of which, the Eocene period, or dawn of recent life, is so named since its rocks contain forms foreshadowing our existing plants and animals. It is the geography and other physical conditions of the lower Eocene in this region to which I wish to direct attention, paying especial heed to the character of the vegetation that clothed the lower Eocene shores. The remains of this old flora are found entombed in the clays of the old lagoons and bayous, preserved as delicate impressions of leaves, flowers and fruits hermetically sealed as they sank and were covered by the fine-grained muds that formed the clays. Their remains in regions that were swamps, or where the lagoons were shut off from rivers with their seasonal loads of sediment, on the one hand, and were likewise separated from the sea by barrier beaches, on the other, rotted and accumulated to form the beds of lignite so common throughout the Gulf states and now mined in many places, particularly in Arkansas and Texas.

The area of this lower Eocene Mississippi Gulf is shown in the accompanying sketch map (Fig. 1).

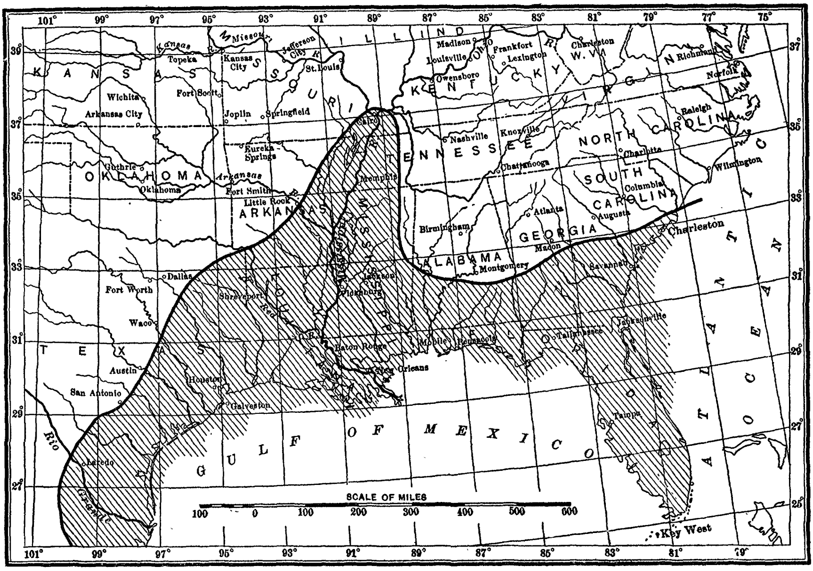

FIG. 1. THE MISSISSIPPI GULF OF LOWER EOCENE TIME.

The title of this article places the antiquity of the Mississippi Gulf shown in Fig. 1 as about three million years. This is, of course, not as fixed as a date in human history, but may be compared with the approximations to dates in human history antedating written records. Geologists have used a great many methods in their efforts to compute the lapse of geologic time, the most readily understandable being that based on the thickness of the sediments and their rate of accumulation. If sediments only accumulated at given rates throughout all time and were never washed away, it would be possible to translate thicknesses into years with considerable accuracy. With the uncertainties surrounding the problem, the most careful calculations are only approximations—useful enough in a way and serving to give a fairly accurate ratio when one geologic period is compared with another. Millions of years mean but little to mortals, the most far sighted of whom rarely think in longer terms than decades or generations, and one can obtain a more impressive concept of the remoteness of this period from the absence at that time of the immediate ancestors of any of our higher animals. If there were ancestral horses thus early, they were small as foxes and had five toes on all four feet. If there were ancestral elephants, they had a full complement of teeth, and their incisor teeth had not commenced to lengthen into tusks or their upper lip elongate into a trunk. The huge uncouth reptilia of the age of reptiles still lingered in the land. The forests were filled with extinct trees and were more like those of Brazil in their physiognomy than like any now growing in our southern states. The loftiest modern mountains—the Himalayas—like the Alps, had not yet lifted their heads. Man was not even a promise and we may be sure that whatever the exact number of years, thousands of years multiplied into millions. And yet it is possible to piece together a very satisfactory picture of the life and its environment from a combination of the study of the character of the sediments and of the forms of life they contain.

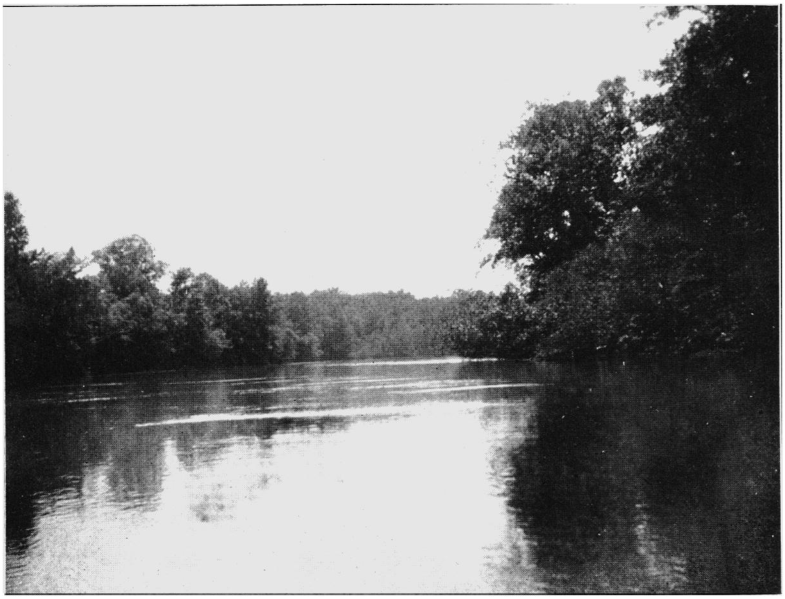

FIG. 2. A RECENT VIEW TO ILLUSTRATE THE PROBABLE APPEARANCE OF A LOWER EOCENE BAYOU ON THE NORTHERN MISSISSIPPI.

First of all, the shores were low and the streams were slow and meandering, expanding in their lower courses into broad forested swamps and winding bayous inhabited by crocodiles. Such a bayou is indicated by the deposits near Oxford, Mississippi, where river clams are found in the clays and the drifted vegetation in certain layers is much broken. In other layers one finds a profusion of the leaves of a fan palm, sometimes three feet across and not unlike the modern palmetto that must have been exceedingly abundant in the delta region. Elsewhere one can trace the outline of these old bayous by the lignitic black clays, and sometimes, where sand and silt failed to penetrate a swampy estuary, the vegetable material has afforded coal-mining developments, as at Hoyt, Texas, where mining operations have followed the narrow winding coal bed for a distance of about three miles. The probable appearance of such a bayou is indicated in Fig. 2.

Beyond the strand there stretched lagoons of quiet water often very wide and at times completely shut off from the sea by barrier beaches covered with strand plants which formed a beach jungle, such as one meets with in the present-day tropics. The extent of many of these landlocked lagoons is marked to-day by the lenticular beds of clay imbedded in the sands and narrowly elliptical in form, their long axes parallel with the old shore line. The climate of the lower Eocene was mild, for we find traces of the breadfriut tree in Arkansas and Louisiana; a host of fig trees, camphor trees and rain trees in Tennessee, and palms everywhere. The character and quantity of the vegetation shows also that the rainfall was abundant.

A total of over 350 different species of plants have been described from these deposits, and some of the plants recognized are of exceptional interest. There are great quantities of camphor trees and laurels, the former so abundant to-day in the Orient and the latter so common in northern South America. The fig, or banyan, family also furnishes a large number of species, including three or four different members of the breadfruit tribe. Another very large alliance was the Leguminosæ which, to mention only such modern forms as have fossil relatives in the lower Eocene, include our acacias, mimosas, locusts, rosewoods, Judas trees, rain trees, sennas and horsebeans. Other especially well represented families are the soapberry (Sapindaceæ), myrtle (Myrtaceæ), sapota (Sapotaceæ) and combretum (Combretaceæ).

Among the more interesting finds was the remains of the nuts of a Nipa palm. The modern Nipa comprises but a single gregarious species inhabiting the tidal waters of the Indian ocean and ranging from the Sunderbunds of the Ganges through Malaysia to the Philippines. It is a stemless form with clusters of gigantic pinnate leaves rising directly from the mud of the tidal flats. The nuts are borne in clusters and resemble small, ribbed coconuts. The estuaries of the Ganges and other oriental streams, as well as ocean currents off the southeastern coast of Asia, often carry large numbers of these nuts in their drift, exactly as did the currents along the shore of the lower Eocene Mississippi embayment and in the Eocene estuaries of southern England, the Franco-

Belgian basin and southern Russia. The habit and environment of the modern Nipa are shown in Fig. 3. The mild climate of the Eocene was world wide in its extent and similar. Nipa nuts have been found in Europe at that time as far north as southern England. They are exceedingly common in the estuary clay of the island of Sheppey in the Thames basin. None, however, have previously been found in the whole western hemisphere.

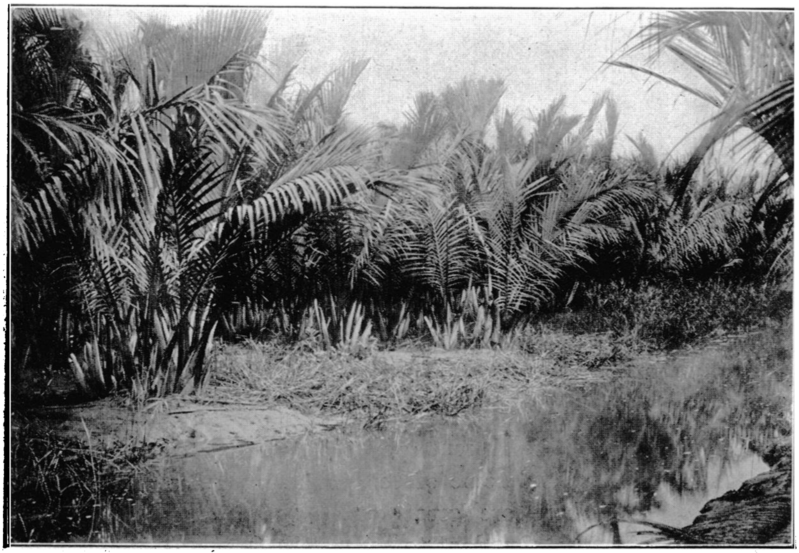

FIG. 3. A TIDAL NIPA PALM SWAMP IN THE PHILIPPINES TO ILLUSTRATE LOWER EOCENE CONDITIONS IN MISSISSIPPI. (Courtesy of Philippine Bureau of Science.)

Another exceedingly interesting find was the winged fruits as well as the leaves of several species of *Engelhardtia*. *Engelhardtia* is a genus of trees belonging to the walnut family, but, unlike the walnuts and hickories, the seed part of the fruit has remained small, thus facilitating the production of a large number of seeds. The bracts, which are inconspicuous in the walnut, have become enormously enlarged in the *Engelhardtias*, so that each seed has three large wings to aid its dispersal. In our lower Eocene the oldest known representative of these trees shows the initial type of the winged fruits, so much more primitive than *Engelhardtia* that it is referred to a new genus named *Paraengelhardtia*. Associated with *Paraengelhardtia* are true Engelhardtias, also the oldest known, and both are new to the western hemisphere. The modern forms number about a dozen, and all but one of these are confined to the Orient, where they range from the northwestern Himalayas through farther India and Burma to Java and the Philippines. One form, probably a descendant and relic of this abundant Eocene display in the Mississippi embayment region, is still found in the mountains of Cost Rica, and a considerable number are found in the upper Eocene and later Tertiary of central and southern Europe.

Sometimes such delicate objects as flowers are preserved in the clays and two of these are shown in Fig. 4. The larger with the long-exserted slender stamens and large anthers is named *Combretanthites* or *Combretum* flower, and belongs to the family Combretaceæ, or Terminaliaceæ, as it is sometimes called. The family comprises about 16 genera and 285 existing species of shrubs, trees and tropical vines found on all the continents except Europe and Antarctica. Many of the forms are strand types and several are characteristic of the tidal mangrove swamps. Nine species belonging to this family and referred to the genera *Combretum, Terminalia, Conocarpus,* and *Laguncularia* are found in the lower Eocene of the Mississippi embayment. The last two are mangrove plants, occurring in swamps on both sandy and muddy bottoms in brackish tidal waters. Both are distributed by ocean currents from tropical America to the west coast of Africa. *Laguncularia,* the buttonwood or white mangrove, has never been found fossil before, although we find both leaves and fruit in the clays of Mississippi and Tennessee. Only one other fossil occurrence of *Conocarpus* is known and that is European and much later in age.

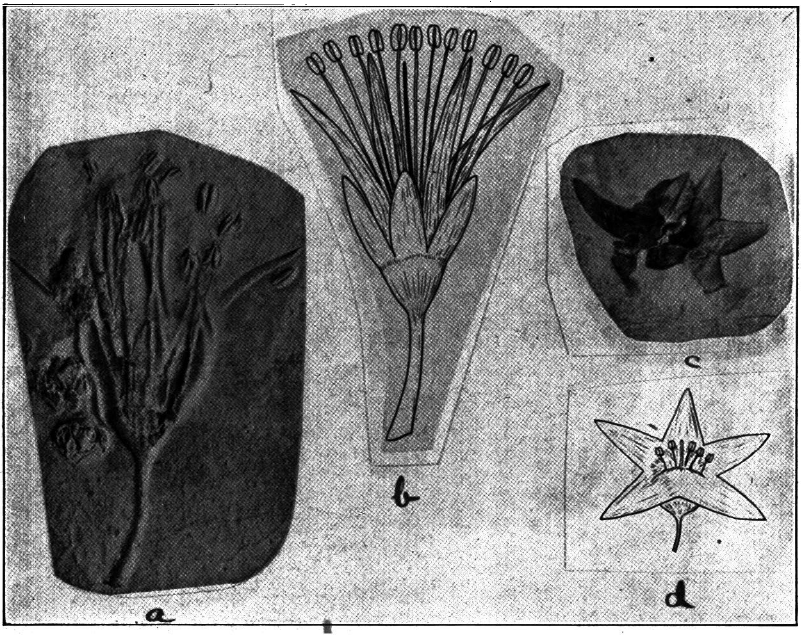

FIG. 4. FOSSIL FLOWERS FROM THE LOWER EOCENE OF THE GULF COAST *a,* Combretanthites as photographed; *b,* Restoration of the same; *c,* Solanites as photographed; *d,* Restoration of the same.

The second flower figured is called *Solanites,* since it belongs to the night-shade family or Solanaceæ, the family that contains our modern potatoes, tomatoes, tobacco, etc. The family is a large one in existing floras and mostly tropical in its distribution but its geologic history is almost entirely unknown. One other *Solanites* flower has been described from somewhat younger deposits in southern France.

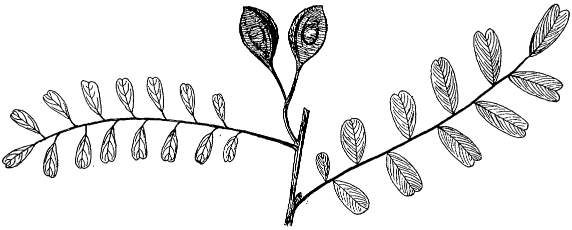

FIG. 5. RESTORATION OF LOWER EOCENE DALBERGIANS FROM TENNESSEE. A composite of Dalbergia monospermoides (fruit) Dalbergia wilcoxiana (leaflets at left) Dalbergia eocenica (leaflets at right).

A genus of trees which were very abundant in the lower Eocene of both this country and Europe belongs to the oak family or Fagaceæ. It is entirely extinct and is called *Dryophyllum.* Its leaves are much like those of the modern chestnuts and chestnut oaks, and they are very abundant throughout the lower Eocene of the Mississippi embayment, several species being represented. *Dryophyllum* is considered to represent the ancestral stock from which the modern oaks and chestnuts descended.

Among the Leguminosæ, which I have already mentioned as being very abundant, are several which deserve some special comment. Among these are seven species of the genus *Sophora,* evidently strand types, and one of these, which was exceedingly abundant in west Tennessee, is scarcely to be distinguished from the existing cosmopolitan strand plant of the tropics, *Sophora tomentosa.* Another interesting find belonging to this family was the trifoliate leaves of two species of *Canavalia,* the first ever found fossil. One of these is almost identical with the existing vine *Canavalia obtusifolia,* a widely distributed tropical strand plant, found in abundance on the sandy beaches of the West Indies, prostrate on the sand or clambering over the beach jungle. A third genus of this family, *Dalbergia,* to which the rosewood of commerce belongs, is represented by four species. The leaves of two of these combined with the characteristic one-seeded pods as they occur in the clays of western Tennessee are shown in the restoration, Fig. 5. Another leguminous genus exceedingly abundant in our lower Eocene, where it is represented by eight species of leaves and pods, is the extinct genus *Gleditsiophyllum.* A restoration of the commonest form which greatly resembled our modern honey locust is shown in Fig. 6.

One other genus of legume deserves special mention, since it has an abundance of fossil leaves and pods. This is the genus *Cassia,* to which the senna as well as our common herbaceous sensitive plants belong. The modern cassias range from herbs to trees and are very abundant and varied, between three and four hundred species having been described from the warmer temperate and tropical climes of all the con-

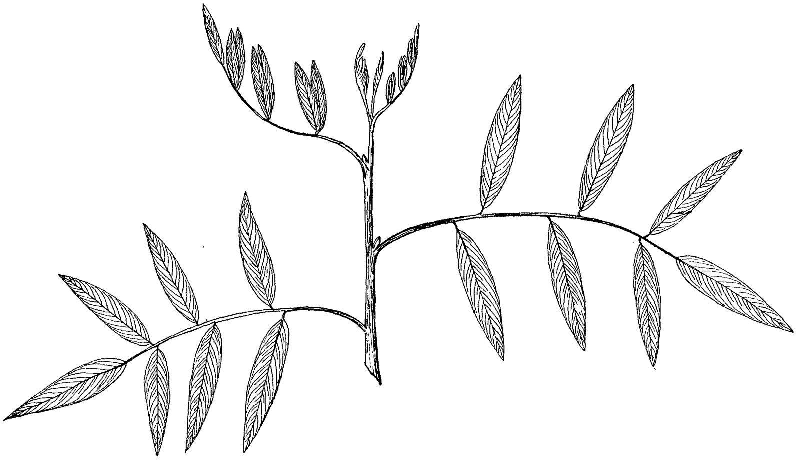

Fig. 6. Restoration of Gleditsiophyllum eocenicum Berry. From the Lower Eocene of Tennessee.

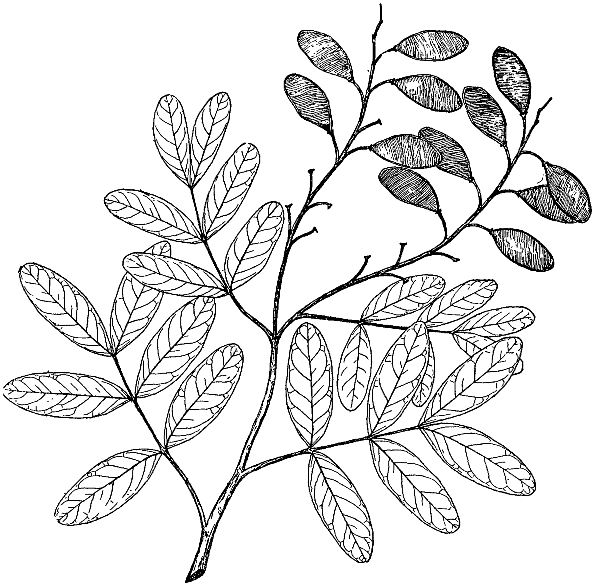

Fig. 7. Restoration of a Fossil Cassia abundant in the Lower Eocene of Mississippi and Tennessee.

tinents. They are especially common in tropical America and have a long geological history extending from the Upper Cretaceous age to the present. Twelve different species have been discovered in the lower Eocene of the Mississippi embayment and a restoration of one of these that had both its pods and leaves preserved is shown in Fig. 7.

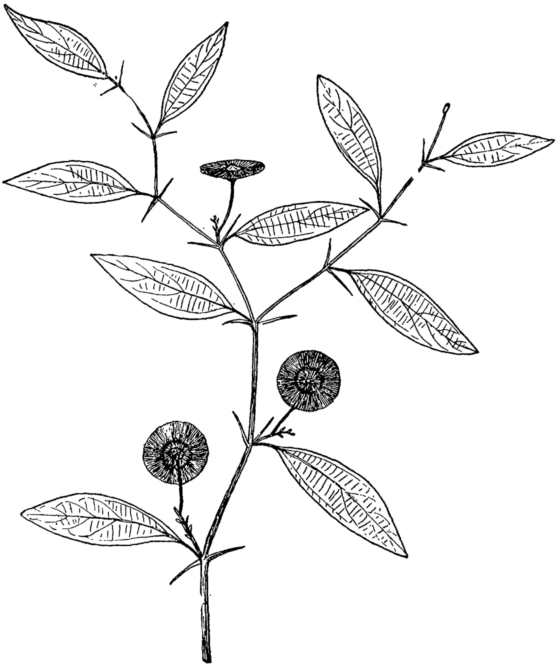

FIG. 8. RESTORATION OF PALIURUS based on Fruits and Leaves found in the Lower Eocene of Mississippi and Tennessee.

A family of plants no longer found in temperate North America is the family Sterculiaceæ, which also has a long and interesting geological history extending from the Upper Cretaceous to the present. Among the fossil leaves of the lower Eocene are an abundance of large three, four or five lobed leaves, eight to ten inches across, of a magnificent *Sterculia,* scarcely distinguishable from the modern Asiatic *Sterculia platanifolia,* which is often cultivated in the parks of our southern states. There are also large five-celled capsules of two species belonging to this same family. These I have called *Sterculiocarpus,* since they are not exactly like those of any of the existing genera of this family.

I will mention but one other of the 63 families that are represented in this remarkable lower Eocene flora.

The buckthorn family or Rhamnaceæ has furnished no less than fourteen fossil species in this area, representing the genera *Rhamnus,* *Rhamnites, Reynosia, Zizyphus* and *Paliurus*—the first being the most varied with six species. The genus *Paliurus* is of especial interest, not only because it is represented by the very characteristic fruits as well as by the leaves, but because it has such an extended geologic history and was formerly cosmopolitan. In the later Tertiary it dwindled, and in the existing flora it has only two species which are found from southern Europe through southern Asia to China and Japan. Fossil forms are found as early as the Upper Cretaceous, at which time at least a dozen species, all North American, have been described, seemingly indicating an American origin for the genus. The leaves are not common in the lower Eocene of the embayment, but the characteristic peltate fruits are not rare, and the two combined have furnished the data for the restoration shown in Fig. 8.

One might cover many pages with comments concerning fossil malvaceas, cedrellas, laurels, bombaceas, apocyneas, malpigias and all the other interesting fossil plants that give us a glimpse of the vegetation of this far-distant chapter of earth history. This flora, the first of its kind that contained types that invaded our country from the south, has been rather fully described recently and the reader who wishes to know more about it is referred to the published account.[1]

It must not be supposed that the strand line which seems to be such a striking and constant geographic feature remained stationary in the position shown in Fig. 1. The strand advanced and receded many times, as it has always done in all parts of the world. Geologic events, however, move with such extreme slowness when measured by human standards that such changes are not perceptible to contemporary life. At the beginning of the Eocene the coast line of the Mississippi Gulf was far to the southward, almost where it is to-day, and the advance of the sea northward to the mouth of the Ohio was a gradual process requiring some thousands of years for its accomplishment and measured by an observable evolution in the life forms found in its sediments. This constitutes one of the practical applications of paleontology, since, given a collection of fossil plants or shells, the paleontologist can tell the geologist whether a particular stratum is young or old and into just what niche of geologic time to fit his coal bed or artesian water horizon.

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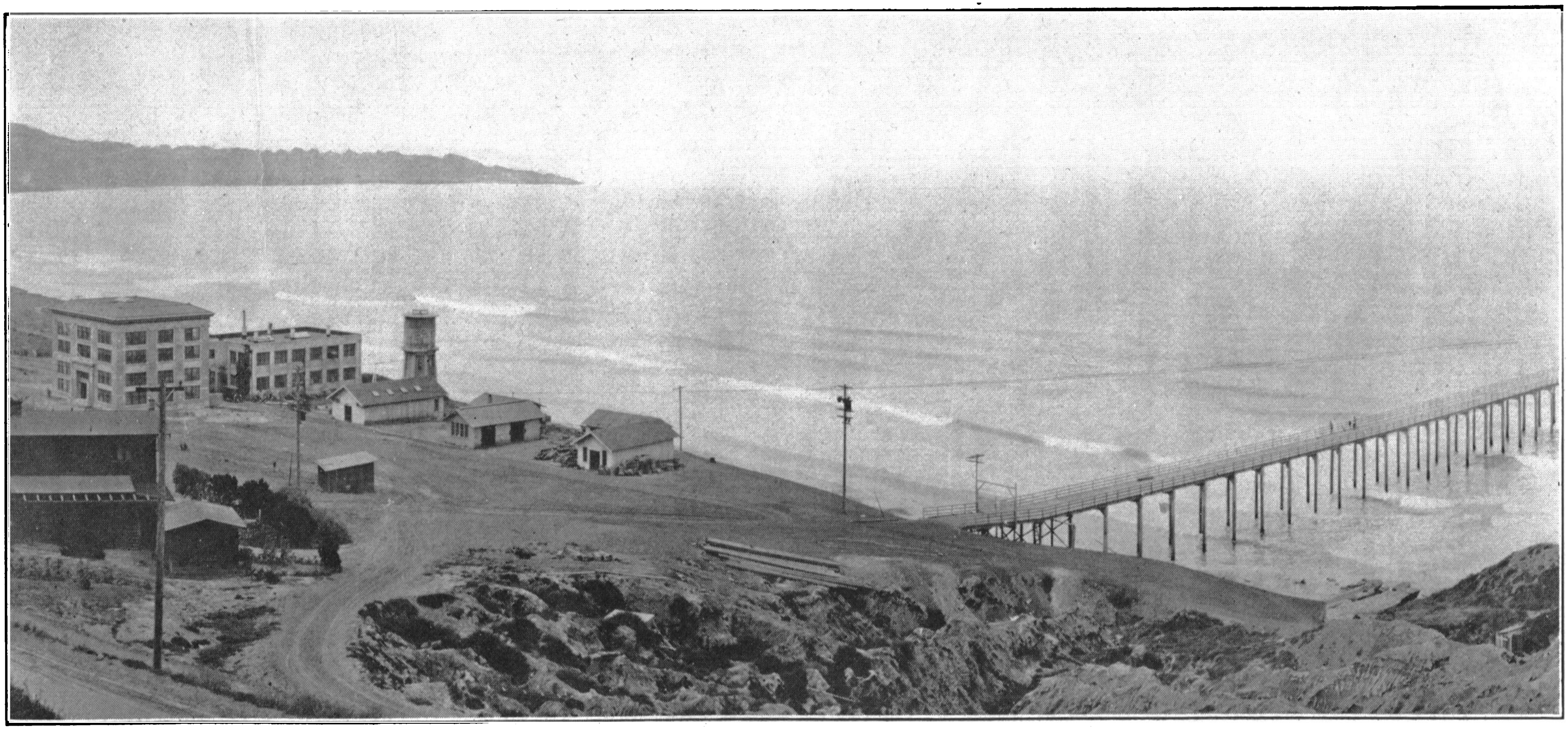
[1] Professional Paper 91, U. S. Geol. Survey.



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